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EMBRYOLOGY.[1]

Entwicklungsmechanisches.—Awaiting the publication in the Zeit. f. Wiss. Zool. of a fully illustrated account of his exceedingly important work upon the value of cells in cleaving eggs, Hans Driesch[2] puts forth a short preliminary notice of results recently obtained at Naples.

Having previously shown[3] that one of the first two cleavage cells in an echinoderm could, by itself, form a complete larva, the author now wishes to combat the view that any real process of regeneration here leads to the formation of the symmetrical whole animal from the half ovum. This idea of a regenerative process has just been maintained by Chun in a paper presented to the *Deutsche Zool. Gesellschaft,* and very briefly noticed in the *Zool. Anz.,* xv, June, 1892, p. 225. Chun separated the first two cleavage cells of the Ctenophore *Bolina,* and found each could produce a half-animal that later became a complete one by regeneration. This process was seen also in many eggs not artificially interfered with.

Hans Driesch removes one of the first four cleavage cells of a sea-urchin and finds the remaining three cleave as if the fourth were still present, yet later a normal, but smaller, blastula (and in more than twenty cases a normal pluteus) is formed. One of the four cells may also, in some cases, give rise to a normal but very small pluteus.

Thus we may take almost any fraction of the cleavage material and, if it is not *too* small, obtain an animal differing from the normal only in size.

The author maintains that there is no re-formation of the removed cleavage material, but the amount present closes in to form a small blastula. There is no regeneration.

In these facts is also seen the fundamental identity of the cleavage cells, their lack of preordination. To emphasize this conception of the value of cleavage cells the author communicates the results of experiments the details of which we hope will soon be made known in his complete demonstration. In the egg of the sea-urchin the first three spindles lie in an equatorial plane, then the next four in a vertical plane (whence the eight cells, four above and four below, result). Now by the application of pressure it is possible to force all these spindles to lie in one plane, whence there results a plate or single layer of eight cells. These cells may remain in this abnormal position and divide vertically so that there are two layers of eight or in all sixteen cells, which subsequently divide tangentially. A little consideration will convince one that here cells, or nuclei, normally forming part of only one pole, give rise to parts of both poles. Since these confused cleavage cells may proceed to form normal plutei their indifferent, omnipotent character cannot be disputed.

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[1] This department is edited by Dr. E. A. Andrews, Baltimore, Md.

[2] Anatomischer Anzeiger, vii, Aug., 1892.

[3] See AMERICAN NATURALIST, Feb., 1892, p. 178.

These and other experiments, not here revealed, lead Hans Driesch to the following conceptions of the value of cleavage: (1) Cleavage forms a homogenous, indifferent material any portion of which, almost, may form a complete organism when isolated or any part of an organism when united with other portions. (2) The embryo acquires form through unknown laws of correlation; it is not a mosaic as Roux has maintained.

Budding in Hydroids.[4]—Contrary to the usually received conception, Mr. Albert Lang, working with Prof. Weismann, contends that in hydroids buds are formed not by equal outgrowth of both ectoderm and entoderm, but primarily by the growth of the ectoderm alone, this germ layer early giving rise to a new entoderm for the bud.

In an introductory note Prof. Weismann relates that purely theoretical reasons, the probability that "bud idioplasm" is confined to certain cells of the ectoderm, led him to doubt the participation of the entoderm in the formation of hydroid buds.

The body of the paper is devoted to a description of sections made through *very early* stages in the budding of *Eudendrium racemosum*, *E. ramosum*, *Plumularia echinulata*, and *Hydra grisea*, preserved for the most part with the aid of corrosive sublimate.

Although in the stages usually examined the ectoderm and entoderm of the bud are continuous with those layers in the adult and surround a prolongation of the gastric cavity of the adult, yet the study of very early stages shows that this continuity does not arise by mere proliferation in each layer. At first there is a thickening of the ectoderm over the area that is to give rise to the bud; here the basement membrane appears to be dissolved; is at all events absent; thus ectoderm and entoderm are here continuous with one another; rapid cell division takes place in the ectoderm, while the entoderm seems to remain passive, or after a time is even cast off or degenerates; certain small ectoderm cells *appear* to migrate into the entoderm and are interpreted by Mr. Lang as there giving rise to a new entoderm. While a new basement membrane is soon formed over most of the budding area it remains indistinct or absent around the periphery; a solid outgrowth is thus formed, within which a cavity appears by the separation or rearrangement of the new entoderm and loss of the old; we thus arrive at the two-layered, hollow outgrowth commonly regarded as the earliest stage in the formation of the bud.

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[4] Zeit. f. Wiss. Zool., 54, July, 1892, pp. 365–383.

Unfortunately the illustrations given by the author are not numerous enough to convey to the reader the same convictions that the study of series of sections might. The equally important and difficult questions, the migration of ectoderm cells and their conversion into new entoderm seem to require a reinvestigation of the subject before we can be fully convinced that the ectoderm is really the only seat of proliferation in budding hydroids.

Comparing this bud formation with embryonic processes, the author points out the close parallelism between the formation of new entoderm by multipolar migration from the ectoderm of the bud and the formation of the entoderm of the embryo by migration of ectoderm cells of the blastula.

Instead of regarding the process of budding in coelenterates as a modified fission of the adult we may refer it back to the blastula stage and explain it as acquired in some ancestral blastula form, as an atavistic representation of a non-sexual mode of reproduction in a blastula-like coelenterate ancestor.

Similarly Seeliger has interpreted budding in Bryozoa as due to a process of twin-formation in the embryo.

Budding in annelids, tape-worms and scyphistomas, where all germ layers are concerned, may still be regarded as having arisen from regenerative processes. Budding in Salpa remains unexplained.

Notes on Elasmobranch Development.[5]—Prof. Adam Sedgwick brings forward some new facts and considerations tending to support his theory of the origin of metamerism in animals and also making clearer his views upon many important questions illustrated by his observations upon the embryos of Scyllium and Raia.

The blastopore of elasmobranchs, immediately before it closes, is an elongated, narrow slit, slightly dilated in front, where it lies on the floor of the medullary canal, and more dilated behind (Balfour's yolk-blastopore). Between these two limits it takes the course of a reversed letter S. The anterior part perforates the medullary canal and is dorsal; this is continuous round the end of the tail with a ventral part, which extends forward along the ventral side of the tail as far as the yolk-stalk. Along this it passes to continue backward along the yolk as the slit-like, non-embryonic part of the blastopore, which passes behind into the more dilated and posterior part of the so-called yolk-blastopore. In the author's view the blastoderm grows uniformly over the yolk at all points of its circumference. The notch of the embryonic rim represents the anterior end of the blastopore and the blastopore does at one time or another perforate the whole length of the medullary plate; anteriorly it keeps closing up as the embryonic rim grows backwards, so that it is never present in this region as more than a notch. Yet there is no "concrescence"—" to talk about concrescence and fusion of two halves is merely obscuring the real question and seeking to explain a process of growth by a phrase which has no satisfactory meaning."

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[5] Quart. Jour. Mic. Sci., June, 1892.

The anus is formed within the area of the blastopore; is actually a part of the blastopore in some vertebrates; not so the mouth.

In *Scyllium canicula* the mouth is at first a longitudinal row of dots between the mandibular arches. These pores become connected to form a longitudinal slit extending forward into the rudiment of the pituitary body. Later the mouth shortens and widens to the adult form. Its slit-like form may be favorable to the view that it is derived from the anterior part of the blastopore, " though I admit that this does not constitute a very powerful argument."

The mandibular, hyoid and branchial arches are very much bent backward, which suggests that there has been not only a cranial but a cephalic flexure affecting brain, notochord and arches as well. Before such a flexure the mouth was a vertical slit looking forward or even extending onto the dorsal surface.

Regarding the metamerism of the head the author thinks that the number of primitive somites in any region of the head differs in closely allied genera. Hence the adult segmentation, constant throughout the vertebrates, has little value in determining the primitive metamerism. " We may, I think, even go farther and say that the adult arrangement of nerves and branchial arches, etc., characteristic of the vertebrate head, must have arisen subsequently to the disappearance of the primitive segmentation." The first or premandibular somite of Balfour, arising from a mass at first connected with the ectoderm, with the notochord and with the anterior end of the gut, thus presents some resemblance to the primitive streak of the Amniota, and appears to contribute as a growing point to the anterior end much as the primitive streak does to the posterior end of the embryo.

Turning now to quite a different subject, the author affirms that in all the vertebrate embryos he has examined there is a protoplasmic continuity between the different layers and organs. "The cells of the young embryo, subsequent to cleavage, are connected by delicate processes. There can be no reasonable doubt that it (the network of such processes) is derived from the processes and strands left between the cells as a result of the incomplete cleavage of the ovum." Awaiting an investigation of this subject, which the author hopes to treat of in a future paper, he yet thinks "that there is, in my opinion, evidence to show that the whole of the nervous connections (by nerve-fibres and otherwise), both in the central organ and at the periphery, are developments of this pre-existing network, which connects together at all times the whole of the cells derived from the fertilized ovum."

Embryology of a Nematode.—A welcome addition to the scant literature of this subject has been made by Benno Wandolleck.[6] He studied fresh and preserved material of *Strongylus paradoxus,* devising some new and interesting methods.

Peculiar changes in the arrangement of yolk-spherules precede cleavage; the first plane is meridional and the cell at the animal pole, where the polar bodies were formed, has no coarse yolk, while the cell at the other end of the elongated egg is completely full of it. The clear cell gives rise to all the ectoderm, and at first is where the anterior end of the animal will be; the granular cell gives rise to the entoderm and the mesoderm, and is at first where the tail of the animal will be. The two cells rearrange themselves so that the ectoblast cell lies partly dorsal and the mes-entoblast cell partly ventral.

Subsequent divisions result in a solid mass of cells in which the more numerous, smaller ectoblast elements form a dorsal cap over the few granular, larger mes-entoblast cells. As an epibolic gastrula begins to form, a pair of mes-entoblasts become recognizable as the primary mesoblasts, whence arise two simple rows of mesoblast cells, one on each side. These two longitudinal mesoblast rows run parallel with the edges of the blastopore slit formed by the overgrowing ectoblast. This blastopore closes completely the anterior part last; at that point the mouth subsequently forms by a new invagination. The entoblast is now only two rows of few, large cells; these subsequently

[6] Archiv. f. Naturg, 58, 1892, pp. 123–147, plate IX.

separate from one another, after their number is increased, to leave the lumen of the digestive tract. Only short stomodeal and anal invaginations arise from the ectoblast.

As the mouth forms, ectoblastic cells around it sink in to form the nervous system. The reproductive organs are recognizable before this, as two large cells, one in each of the rows of only five or six mesoblast cells.

In the main the paper confirms the observations of Götte upon Rhabditis.

Note on an Abnormal Polygordius Larva.—Since reading Mr. E. A. Andrews' article on Bifurcated Annelids in the September number of this journal, it has seemed to me that some notes and sketches which I made during the summer of 1890 while enjoying the privileges of Mr. Agassiz's laboratory at Newport, R. I., are of sufficient interest to warrant their being published. They relate to a case of a peculiar bud formation in Polygordius. The larvæ of this annelid were very abundant for several weeks both before and after the dates here mentioned, and after this abnormal individual was observed all the tow that was brought into the laboratory was carefully examined for similar specimens, but none were found.

Figure 1 represents the larva as it appeared when first seen on August 9. The body was about equal in length to the longest axis of the head. So far as could be seen the head differed in no respect from that of the normal larva.

The bud was situated on the dorsal side of the body close behind the head, and was about equal to the body in both length and diameter, though as shown by the figures it was quite markedly club-shaped, the larger end being distally directed. The outer layer of the bud was distinctly continuous with the corresponding layer of the body, though neither at this nor at any later stage did it show anything of the superficial ring-structure or of the pigment spots, such as were seen in the body. I could not make out precisely the relation of the digestive tract to the bud, though its wall seemed to be folded somewhat in this region, the fold being capable of being thrust into the bud for a short distance.

A mass or thick strand of tissue could be seen within the bud, extending from near its base out to its tip, there to become fused to the inner surface of the distal wall of the bud. This strand was clearly separated all around from the external wall of the bud by an empty space of considerable size, but I could not make out that the strand itself contained a lumen.

Neither at this nor at any later time did the digestion tube extend into the body behind the bud excepting as a mere diverticulum, though there seemed to be a body cavity in this region—more distinctly seen, however, at later stages.

A ciliated band was not present at this time, either at the posterior end of the body or at the tip of the bud, though in each place a circle of pigment spots was to be seen.

On the morning of August 11, forty-eight hours after the first sketch, shown in Figure 1, was made, the one shown in Figure 2 was drawn.

Both body and bud had increased in length considerably, but the former more, proportionally, than the latter. The digestive tube could now be distinctly seen to extend for a considerable distance into the bud, though it was constantly being thrust in for a greater or less distance and again withdrawn. There was a sort of fold just at the entrance that was continually changing its shape and position, by reason of which it was impossible to determine exactly what was the relation of the intestinal wall to the body wall.

The strand of tissue in the bud mentioned as being present in the preceding stage, has practically the same appearance and relations now, excepting that it was proportionally shorter.

The body cavity behind the bud was now quite distinct, and there was a circle of cilia around the body near its posterior end, but none on the bud. At this time the bud could be seen to contract somewhat.

While this sketch was being made the cilia of both the head and the posterior end of the body, together with some of the pigment spots of the head band were suddenly thrown off, and the animal sank to the bottom of the dish and became quiet, whereas it had before this time been swimming rapidly about.

Twenty-four hours later the sketch was made which is represented in Figure 3. The head was now much reduced in size, and the body correspondingly increased in length. The bud had also increased in length somewhat, but much less proportionally than the body.

The most interesting new feature observed at this time was that there was a communication between the digestive tube and the outside world through the bud, the anal opening being situated at the tip of the latter. Conclusive proof of this was furnished by the fact that a mass of fecal matter was seen to pass from the intestine into the bud and then out into the surrounding water. But still I could not be sure as to the real relation of the digestive tube to the external layer of the bud. The fold mentioned in the preceding stage (*a* in Figure 3) was very distinct here, but was not usually in the position shown in the figure, i. e., projecting into the digestive tube, but was most of the time thrust far into the bud, and it is certain that the fecal matter just spoken of passed *through* this. It is my belief from all that I could make out, that the strand of tissue described in the former stages now

FIG. 1.

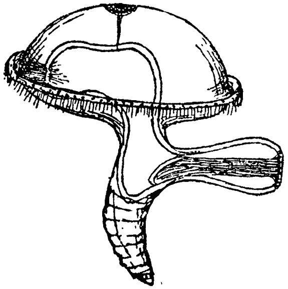


FIG. 2.

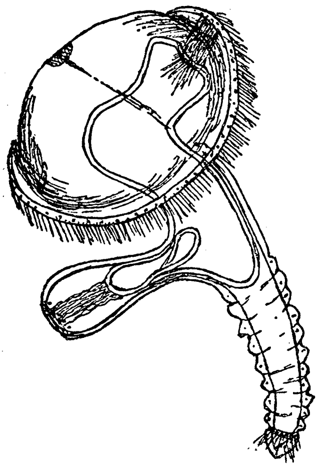
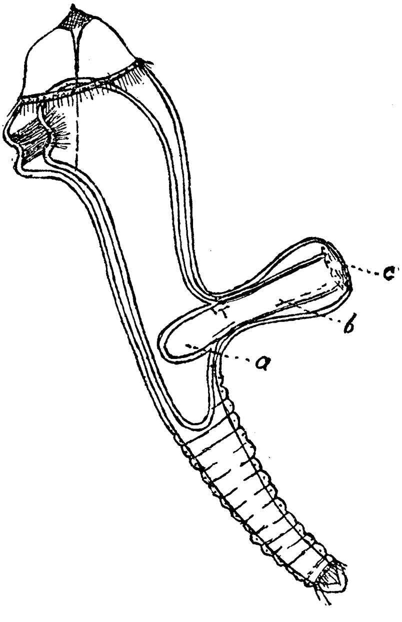


FIG. 3.



contained a wide lumen throughout its length, and that into this the diverticulum of the intestine, with an anal opening at its distal end, was alternately thrust and withdrawn. The fecal mass did not seem to be *carried into* this lumen by one of the eversions of the intestine, as we might now call the portion of the digestive tube that extended into the bud, but to pass directly into the cavity, *b*, and from there to the outside world by the anus at *c*.

Although the fold, *a*, changed its form and position frequently, as already explained, the movements were never seen to affect the portion of the wall of the digestive tube immediately at the entrance of the bud. From this fact and the obvious close relation of the two layers in this region, I conclude that there was an actual connection between them here. At this time both the preoral and anal bands of cilia were present, and the larva was swimming about actively. On the following morning, however, it was dead and so far decomposed as to be of no value as a preserved specimen.

Meaningless, and indeed impossible, as such a comparison would be in detail, one can hardly fail to be reminded by these figures of the young Phoronis at such a stage of its metamorphosis as is figured, for example, by Metschnikoff and copied in Lang's *Lehrbuch der Vergleichanden Anatomie.* Of course, should such a comparison be attempted, the main, or primary body of the Polygordius larva would have to be compared to the new, or secondary body of the Phoronis. Nevertheless, it is worth noticing that we have in this monstrosity, as in Phoronis, a contrivance by which the anus is transferred from the end of the body remote from the head to a position much nearer to it, this being brought about by a dorsal flexure upon itself of the digestive tract, the change being then essentially that required by Wilson's[7] speculation concerning the significance of the eversion of the digestive tract during the metamorphosis of Phoronis.—WM. E. RITTER, University of California, Sept. 27, 1892.

[7] E. B. Wilson. The Origin and Significance of the Metamorphosis of Actinotrocha. Quart. Jour. of Micro. Sci., Vol. xxi, pp. 202–218.